

AF (HFW)

Practitioner's Docket No. P-1187**PATENT****IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re application of: VLADIMIR FRIDMAN, ET. AL.

Application No.: 10/680,544 ✓ Group No.: 1754 ✓

Filed: OCTOBER 7, 2003 ✓ Examiner: Cam N. Nguyen ✓

For: CATALYST FOR DEHYDROGENATION OF HYDROCARBONS Reexamination control No.:
Confirmation No. 4997 ✓

Mail Stop Appeal Brief—Patents
 Commissioner for Patents
 P.O. Box 1450
 Alexandria, VA 22313-1450

REPLY

**TRANSMITTAL OF ~~APPEAL~~ BRIEF
 (PATENT APPLICATION OR EX PARTE REEXAMINATION—
 37 C.F.R. § 41.37)**

NOTE: The phrase "the date on which" an "appeal was taken" in 35 U.S.C. 154(b)(1)(A)(ii) (which provides an adjustment of patent term if there is a delay on the part of the Office to respond within 4 months after an "appeal was taken") means the date on which an appeal brief under § 1.192 (and not a notice of appeal) was filed. Compliance with § 41.37 requires that: 1. the appeal brief fee (§ 41.20(b)(2)) be paid (§ 41.37(a)(2)); and 2. the appeal brief complies with §§ 41.73(c)(1)-(x). See Notice of September 18, 2000, 65 Fed. Reg. 56366, 56385-56387 (Comment 38).

1. Transmitted herewith is the ~~APPEAL~~ BRIEF in this application, with respect to the Notice of Appeal filed on May 5, 2006.

NOTE: Appellant must file a brief under this section within two months from the date of filing the notice of appeal under § 41.31. 37 CFR 41.1(a)(1). The brief is no longer required in triplicate. The former alternative time for filing a brief (within the time allowed for reply to the action from which the appeal was taken)

CERTIFICATION UNDER 37 C.F.R. §§ 1.8(a) and 1.10*

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37 C.F.R. § 1.10 *

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Holly Hart

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* Only the date of filing (§ 1.6) will be the date used in a patent term adjustment calculation, although the date on any certificate of mailing or transmission under § 1.8 continues to be taken into account in determining timeliness. See § 1.703(f). Consider "Express Mail Post Office to Addressee" (§ 1.10) or facsimile transmission (§ 1.6(d)) for the reply to be accorded the earliest possible filing date for patent term adjustment calculations.

2. STATUS OF APPLICANT

This application is on behalf of

other than a small entity.
 a small entity.

A statement:

is attached.
 was already filed.

3. FEE FOR FILING APPEAL BRIEF

Pursuant to 37 C.F.R. § 41.20(b)(2), the fee for filing the Appeal Brief is:

small entity \$250.00
 other than a small entity \$500.00

Appeal Brief fee due \$ _____ (NO FEE DUE FOR FILING
A REPLY BRIEF)

4. EXTENSION OF TERM

NOTE: 37 C.F.R. § 1.704(b) ". . . an applicant shall be deemed to have failed to engage in reasonable efforts to conclude processing or examination of an application for the cumulative total of any periods of time in excess of three months that are taken to reply to any notice or action by the Office making any rejection, objection, argument, or other request, measuring such three-month period from the date the notice or action was mailed or given to the applicant, in which case the period of adjustment set forth in § 1.703 shall be reduced by the number of days, if any, beginning on the day after the date that is three months after the date of mailing or transmission of the Office communication notifying the applicant of the rejection, objection, argument, or other request and ending on the date the reply was filed. The period, or shortened statutory period, for reply that is set in the Office action or notice has no effect on the three-month period set forth in this paragraph."

NOTE: The time periods set forth in 37 C.F.R. § 1.192(a) are subject to the provision of § 1.136 for patent applications. 37 C.F.R. § 1.191(d). See also Notice of November 5, 1985 (1060 O.G. 27).

NOTE: As the two-month period set in § 1.192(a) for filing an appeal brief is not subject to the six-month maximum period specified in 35 U.S.C. § 133, the period for filing an appeal brief may be extended up to seven months. 62 Fed. Reg. 53,131, at 53,156; 1203 O.G. 63, at 84 (Oct. 10, 1997).

The proceedings herein are for a patent application and the provisions of 37 C.F.R. § 1.136 apply.

WARNING: The provisions of 37 CFR § 1.136 do not apply in an ex parte reexamination. Any requests for extension must be made pursuant to 37 CFR 1.550(c).

(complete (a) or (b), as applicable)

(a) Applicant petitions for an extension of time under 37 C.F.R. § 1.136 (fees: 37 C.F.R. § 1.17(a)(1)-(5)) for the total number of months checked below:

Extension (months)	Fee for other than small entity	Fee for small entity
<input type="checkbox"/> one month	\$ 120.00	\$ 60.00
<input type="checkbox"/> two months	\$ 450.00	\$ 225.00
<input type="checkbox"/> three months	\$ 1,020.00	\$ 510.00
<input type="checkbox"/> four months	\$ 1,590.00	\$ 795.00
<input type="checkbox"/> five months	\$ 2,160.00	\$1,080.00

Fee: \$ _____

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If an additional extension of time is required, please consider this a petition therefor.

(check and complete the next item, if applicable)

An extension for _____ months has already been secured, and the fee paid therefor of \$ _____ is deducted from the total fee due for the total months of extension now requested.

Extension fee due with this request \$ _____

or

(b) Applicant believes that no extension of term is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition and fee for extension of time.

5. TOTAL FEE DUE

The total fee due is:

Appeal brief fee \$ _____

Extension fee (if any) \$ _____

**TOTAL FEE DUE \$ 0 (NO FEE DUE FOR FILING A
REPLY BRIEF)**

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Authorization is hereby made to charge the amount of \$ _____

to Deposit Account No. _____

to Credit card as shown on the attached credit card information authorization form PTO-2038.

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Charge any additional fees required by this paper or credit any overpayment in the manner authorized above.

A duplicate of this paper is attached.

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If any additional extension and/or fee is required,

AND/OR

If any additional fee for claims is required, charge:

Deposit Account No. 03-3420

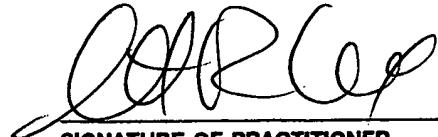
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SIGNATURE OF PRACTITIONER

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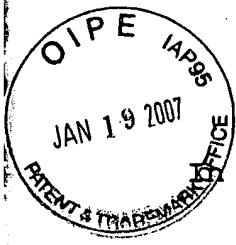
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Louisville, Kentucky 40202

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IN THE UNITED STATES PATENT & TRADEMARK OFFICE

In re application of: : Group No. 1754
Vladimir Fridman, et al. :
Serial No. 10/680,544 : Examiner: Cam N. Nguyen
Filing Date: October 7, 2003 : Confirmation: 4997
Attorney Docket No. P-1187 :
For: CATALYST FOR DEHYDROGENATION :
OF HYDROCARBONS :
:

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Commissioner for Patents
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Alexandria, VA 22313-1450

REPLY BRIEF

Identification Page

The information required for the "Identification Page" is listed above.

This Reply Brief is written in response to the Examiner's Answer, that was mailed on December 1, 2006. Any fees required and any required petition for extension of time for filing the Brief and fees thereof, are dealt with in the accompanying transmittal of this Reply Brief.

STATUS OF CLAIMS

A. Total number of claims. The claims remaining in the application are Claims 1 - 8, 10 - 13, 15 - 20, 24 and 27 - 28.

B. Status of all Claims.

1. Claims cancelled. Claims 9, 14, 21 - 23, 25 and 26 were cancelled in Responses to previous Office Actions that pre-dated the Final Office Action filed by the United States Patent and Trademark Office on February 7, 2006. ("Final Office Action") (The Final Office Action is the Office Action from which Applicants appeal.)

2. Claims withdrawn from consideration but not cancelled: none.

3. Claims objected to: none.

4. Claims allowed or confirmed: none.

5. Claims rejected: Claims 1 - 13, 15 - 19, 24 and 27 - 28. Please note that on Form PTOL 326, the Final Office Action does not list Claim 9 as cancelled and does list Claim 20 as cancelled. Both of these statements are in error.

C. Claims on appeal. The claims on appeal are Claims 1 - 8, 10 - 13, 15 - 20, 24 and 27 - 28. The Claims on appeal are attached as an appendix to this Reply Brief.

GROUND'S OF REJECTION TO BE REVIEWED ON APPEAL

1. Claims 1 - 2, 5 - 8, 10 - 13, and 28 stand rejected under 35 USC §103 as being obvious over Zimmermann, et al. (U.S. Patent No. 5,378,350) taken together with Kerby, et al. (U.S. Patent No. 5,258,567).

2. Claims 3 - 4, 15 - 19, 24 and 27 stand rejected under 35 USC §103 as being obvious over Zimmermann, et al. (U.S. Patent No. 5,378,350) taken together with Kerby, et al. (U.S. Patent No. 5,258,567) as applied to Claims 1 - 2, 5 - 8, 10 - 13, and 28, and further in view of Hamner, et al. (U.S. Patent No. 4,212,771). (Presumably Claim 20 is also rejected for these same grounds.)

ARGUMENTS

1. Rejection of Claims 1 - 2, 5 - 8, 10 - 13 and 28 under 35 USC \$103 based on Zimmermann, et al. taken together with Kerby, et al. is not appropriate.

Introduction

The applicants have discovered and claimed in independent Claim 1 and the dependent claims depending thereon, a new dehydrogenation catalyst which is particularly useful for vapor phase dehydrogenation. The catalyst consists essentially of a) chromium oxide on b) a carrier with two promoters: c) zirconium and d) magnesium. Independent Claim 13 claims the subject matter of Claim 1 but adds to the composition of the catalyst of Claim 1 component e) an alkali metal promoter, selected from sodium, potassium and mixtures thereof.

Zimmermann, et al.

The primary reference cited by the USPTO, Zimmermann, et al., disclose a catalyst comprising a) chromium on b) an alumina carrier to which is added c) zirconium and d) cesium. The only additional promoters that are suggested by Zimmermann, et al. are disclosed at Col. 2, lines 21 - 29 and are scandium, yttrium, a lanthanum compound, or a titanium or hafnium compound. The primary teaching of Zimmermann, et al. is that a conventional dehydrogenation catalyst containing chromium oxide on an alumina support with zirconium oxide can be improved by adding a cesium promoter.

However, the results that can be achieved with cesium compounds as promoters are outstanding. Catalysts which contain 0.1 to 10, preferably 1 to 5, % by weight of a cesium compound, calculated as Cs₂O, have proven to be especially effective. (Col.2, lines 16 - 20.)

Zimmermann, et al. contain 16 Examples of catalyst compositions, all of which contained chromium and zirconium on an alumina carrier. (See Col. 4 - Col. 6) Ten of the Examples also contained cesium promoters. In the remaining six examples, the cesium promoter was replaced by the following alternative promoters: K₂O, Na₂O, BaO, CaO or NaOH. The improvement in the performance of the catalysts which contained a cesium promoter over the catalysts with the other 6 promoters was substantial as noted by Zimmermann, et al.:

Further it can be seen from table I that cesium compounds, in comparison to the other alkalis and alkaline earths, prevent the coke formation most effectively. But this effect is dependent in a certain way on the concentration of the cesium compound in the catalyst.

In FIG. 1, the percentage coke deposit, relative to the propane used, is applied against the concentration of CsOH in the catalyst. As can be seen, there is a pronounced minimum of the coke formation between 2 and 3 % by weight of CsOH. In these tests performed with propane, except for the very small coke formation, an extraordinarily high selectivity was achieved... (Col. 6, lines 50 - 61)

In addition to the specific disclosures within Zimmermann, et al., all claims of Zimmermann, et al. claimed a catalyst comprising chromium on an alumina carrier and further including zirconium and

cesium. No other components for the catalyst are claimed.

The Examiner acknowledged the differences between the invention, as claimed, and the catalyst as disclosed and claimed by Zimmermann, et al., as follows:

Thus, the only difference between the claims and the Zimmermann reference, is that Zimmermann does not disclose the magnesium and alkali metal promoter (sodium or potassium) together, and he does not disclose the magnesium concentration either. (Examiner's answer, page 5, first para.)

In fact, a more accurate statement of the difference is that Zimmermann, et al. determined that it was preferable to add cesium to a dehydrogenation catalyst already containing chromium and zirconium on an alumina carrier. In contrast, the inventors chose magnesium rather than cesium as the preferred promoter.

Kerby, et al.

In order to overcome the deficiencies in Zimmermann, et al., the Examiner cites Kerby, et al. Kerby, et al. disclose a dehydrogenation catalyst containing a) an active metal selected from the group consisting of Pt, Cr, Pd, Ir, Rd and mixtures thereof, and b) a modifier metal selected from the group consisting of Sn and Ga placed on c) a carrier. The carrier is a "pillared tetrasilicic fluoromica." The primary innovation of Kerby, et al. is the utilization of this unique carrier material. Notwithstanding, Kerby, et al. do disclose that d) a second

modifier metal may be added to the catalyst, which second modifier may be selected from the group consisting of all alkali metals, alkaline earth metals, and rare earth metals. The total number of elements that qualify as alkali metals, alkali earth metals and rare earth metals is 27.

The Examiner concludes in the Examiner's Answer that

It would have been *prima facie* obvious to one of ordinary skill in the art at the time the invention was made to have added magnesium to the catalyst of Zimmermann in order to achieve an improved catalyst having promoted activities because it is known as useful catalyst promoter (or modifier) as evidenced by Kerby...

Obviousness Analysis

The issues relating to "obviousness" are well recognized and are discussed in a number of cases and also in the MPEP beginning at MPEP 2141. Notwithstanding, it is important to review the requirements of an obviousness analysis.

An obviousness analysis begins with the United States Supreme Court case of Graham v. John Deere Co., 383 U.S. 1 (1966). In that case the Court established a three (actually four) part test for determining obviousness: 1) determining the scope and content of the prior art, 2) determining the differences between the prior art and the claims at issue, and 3) defining the level of ordinary skill in the art at the time of the invention. (A number of secondary considerations may also be relevant to the determination of obviousness in some cases.)

Mere identification in the prior art of each element is insufficient to defeat the patentability of the combined subject matter as a whole. In re Kahn, 78 USPQ 1329, 1335 (Fed. Cir. 2006). Rather, to establish *prima facie* obviousness based on a combination of references requires the Board to articulate the basis on which it would have been obvious to make the invention. In practice this requires the Board to explain the reasons why one of ordinary skill in the art would have been motivated a) to select the cited references and b) combine them to create the invention. In re Rouffett, 149 F.3d 1350, 1357 (Fed. Cir. 1998). When the

Board fails to discover a motivation or suggestion or teaching that would have led a person skilled in the art to the claimed invention from the cited prior art, the only method by which obviousness could have been determined is from an improper hindsight analysis. In re Kahn, 78 USPQ at 1335, In re Rouffett, 149 F.3d at 1358.

In effect, the Courts and the USPTO have agreed that a determination of obviousness is sustainable only when a suggestion, motivation or teaching exists that "bridges" the differences between the prior art and the claims at issue. Thus, the focus of the analysis in an obviousness determination is on a) the differences between the prior art and the claims at issue and b) whether those differences would have been "bridged" by a person skilled in the art reviewing the references cited at the time of the invention.

Differences between the prior art and the claims at issue

1. Teachings of Zimmermann, et al. The catalysts of Zimmermann, et al. contain the following components: a) a support, such as alumina, b) an active metal consisting of chromium, c) a promoter consisting of zirconium, and d) an additional promoter consisting of cesium. In Zimmermann, et al. cesium is preferred over all other alkali or alkaline earth metals, as discussed at Col. 6, lines 50 - 64 and as shown in table I. (Additional promoters that are specifically disclosed in Zimmermann, et al. at

Col. 2, lines 21 - 29 are irrelevant to the determination in this case as none of those additional promoters are elements of the invention, as claimed.)

2. Teachings of Kerby, et al. The catalysts of Kerby, et al. require a) an active metal selected from the group consisting of Pt, Cr, Pd, Ir and Rd, b) a modifier metal selected from the group consisting of Sn and Ga, and c) a carrier which is a pillared mica compound. Kerby, et al. also disclose that a second modifier may be added, which modifier is selected from a group consisting of 27 elements, including all alkali metals, (Li, Na, K, Rb, Cs and Fr), all alkaline earth metals (Ca, Mg, Be, Sr, Ba and Ra), and all rare earth elements (La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu). (Col. 2, lines 22 - 25.) Notwithstanding the non-specific disclosure of Kerby, et al., the Examiner has asserted that Kerby, et al. teach that magnesium should be incorporated into the catalyst of Zimmermann, et al..

3. All parties acknowledge that Zimmermann, et al., fail to teach the addition of magnesium to their catalysts. (This distinction is acknowledged by the Examiner on page 5 of the Examiner's Answer.)

4. Zimmermann, et al. do teach that cesium is the strongly

preferred promoter for their dehydrogenation catalyst which is combined with Cr, Zr and alumina. The catalyst of the invention does not require cesium or even suggest the addition of cesium in any of their claims, any Examples or anywhere in the specification. Instead of cesium, the applicants claim magnesium. Further, it is clear from the disclosure of Zimmermann, et al. that the problem to be solved by the catalyst of Zimmermann, et al. is "what is the best composition for a dehydrogenation catalyst which produces low coke deposits?" The answer from Zimmermann, et al. is a dehydrogenation catalyst comprising Cr, Zr and an alumina carrier to which a cesium promoter is added.

5. The use of cesium as a promoter to be added to the catalyst of Zimmermann, et al., which already contains Cr, Zr and alumina is preferred over any other alkali metal or alkaline earth metal. This preference is clear from the specification of the Zimmermann, et al. "Further, it can be seen from table I that cesium compounds, in comparison with the other alkalis and alkaline earths, prevent the coke formation most effectively." (Col. 6, lines 50 - 52.) In addition, in table I catalysts containing a cesium promoter performed better than catalysts utilizing instead of cesium a promoter based on potassium, sodium, barium or calcium. Accordingly, Zimmermann, et al. clearly teach that cesium should be used as a promoter instead of any other alkali or alkaline earth metal including magnesium, a required component of the invention.

Thus, Zimmermann, et al. teach away from the use of magnesium with a catalyst containing Cr, Zr and an alumina promoter.

6. The problem to be solved by Kerby, et al. is what type of carrier should be used in a dehydrogenation catalyst to produce the best activity. Kerby, et al. teach that the carrier should be pillared mica. (Col. 11, lines 15 - 22.) Kerby, et al., do not suggest that any of the 27 promoter elements, including magnesium, would assist in the performance of their dehydrogenation catalyst. Rather, they teach the advantages of the choice of the carrier.

"Bridging the gap" between the teaching of Zimmermann, et al. and Kerby, et al.

In order to "bridge the gap" between the teachings of these two references, the burden is on the Examiner to prove that there is some "suggestion", "motivation" or "teaching" to combine these references to arrive at the invention, as claimed. In addition, the problem that is solved by the invention must be similar or the same as the problems that the prior art solved. In re Rinehart, 189 USPQ 143, 149 (CCPA 1976).

The applicants respectfully assert that this "gap" is not bridged by the teachings of the cited references. The applicants respectfully assert that there is no suggestion, motivation or teaching that would lead a person of ordinary skill in the art to combine these references to arrive at the invention, as claimed. In

fact, the applicants assert that the teaching of the cited references teach away from this combination. Further, the problems to be solved by the prior art and the methods of solving those problems that are disclosed by the cited references are distinct from the problems solved by the invention.

1. The primary reference, Zimmermann, et al., taught that an especially effective dehydrogenation catalyst, low in coke deposits, is created by the addition of a cesium modifier to a composition containing Cr, Zr and an alumina carrier. Cesium is preferred over all other alkali metals, such as sodium and potassium. Further, cesium is preferred over all alkaline earth metals, such as calcium and barium, as shown in table I, catalysts nos. 4 and 5. (See also Col. 6, lines 50 - 52) Accordingly, a person skilled in the art reviewing the disclosure of Zimmermann, et al. would recognize the strong preference for adding cesium, as a promoter to a catalyst containing Cr, Zr and alumina, instead of any other alkali metals or any alkaline earth metal modifier, including magnesium.

2. No person skilled in the art trying to solve the inventors' problem of a more selective dehydrogenation catalyst with higher yield would even look to Zimmermann, et al. as the problem to be solved by Zimmermann, et al. was to reduce coke formation.

3. Even if a person skilled in the art did review Zimmermann, et al. and sought an additional promoter for a dehydrogenation

catalyst containing Cr, Zr, Cs and an alumina carrier, they would first look to the promoters specifically suggested by Zimmermann, et al. at Col. 2, lines 20 - 25. These promoters include scandium, yttrium, lanthanum, titanium, zirconium and hafnium with zirconium preferred. None of these promoters are alkali or alkaline earth metals and there is no suggestion of the use of magnesium.

4. Even assuming that a person skilled in the art who was attempting to solve the problem of improving the selectivity and yield of a dehydrogenation catalyst chose the teaching of Zimmermann, et al., and further that that person also decided to review Kerby, et al., there certainly is no motivation or suggestion or teaching to chose magnesium from the many possible modifiers that are disclosed by Kerby, et al.. The person skilled in the art would recognize that higher yield catalysts, as taught by Kerby, et al., would be created only from the use of a pillared mica support. (See Col. 11, lines 16 - 23). If that person skilled in the art reviewing the disclosures of Kerby, et al. did decide to add an additional modifier, he would be taught to add one of the preferred modifiers, selected from Sn or Ga, neither of which is magnesium.

5. Assuming that a person skilled in the art chose to add an additional modifier other than the preferred Sn or Ga to the catalyst of Zimmermann, et al. that already contained Cr, Zr, Cs on an alumina carrier, would that person be taught to add any alkali

metal, alkaline earth metal or rare earth element? None of these 27 possible promoters is preferred by Kerby, et al. In contrast, Zimmermann, et al. teaches that the strongly preferred promoter from this group of 27 is cesium. Where is the motivation in either reference or in the knowledge of a person skilled in the art to substitute magnesium for cesium as a promoter?

6. A combination of references which fails to teach the claimed composition, provides no motivation to combine those references, and does not solve the same problems that are solved by the claimed invention is particularly disallowed when the composition, as claimed, is a catalyst. The Courts and the USPTO have long recognized the unpredictability of "catalytic effects". In re: Doumani and Huffman, 126 USPQ 408, 410 (CCPA 1960). In fact, this unpredictability permitted the patenting of Zimmermann, et al. How else is it patentable to substitute Cs as a preferred modifier for a dehydrogenation catalyst, when the use of other alkali metals, such as Na or K, was well known? In the same way, the applicants have surprisingly discovered the advantages from the addition of Mg instead of Cs to a dehydrogenation catalyst already containing a carrier, Zr and Cr.

7. Accordingly, it is clear that there are significant differences between the prior art cited by the Examiner and the claimed invention. It is also clear that the problems to be solved by these two references lead to the selection of entirely different

compositions for a dehydrogenation catalyst. No person skilled in the art reviewing these references, along with the problems solved by the references, would have been motivated to combine the references in the manner suggested by the Examiner. It is clear that the only reason that the selected teachings from these references were combined in the manner suggested by the Examiner is hindsight. This type of combination of references is not permitted.

The applicants respectfully assert that the combination of Zimmermann, et al. with Kerby, et al. is not motivated or suggested and, even if combined, they do not teach the invention, as claimed, in the claims at issue.

The Rejection of Claims 3 - 4, 15 - 19 and 20, 24 and 27 under 35 U.S.C. §103 based on Zimmermann, et al. taken together with Kerby, et al. and further in view of Hamner, et al. is also not appropriate.

For this rejection the Examiner added Hamner, et al., U.S. Patent No. 4,212,771 to the rejections based on Zimmermann, et al. taken together with Kerby, et al. Hamner, et al. disclose the use of a calcined alumina as the carrier for various catalysts. The Examiner added Hamner, et al. simply to describe the carrier of the catalysts, as claimed.

The catalyst at issue is a dehydrogenation catalyst. In contrast, the carrier of Hamner, et al., as described in his abstract, is utilized with catalysts for "a variety of hydrocarbon treating processes, such as hydrorefining, hydrodesulfurization, hydroconversion, reforming and catalytic cracking." These uses do not include dehydrogenation.

Further, the teaching of Kerby, et al. teaches away from the use of the specific carrier taught by Hamner, et al. Kerby, et al. teach that an especially effective dehydrogenation catalyst would contain a pillared mica instead of the alumina of Hamner, et al as a carrier.

Notwithstanding, the applicants acknowledge that the patentability of the claims which are rejected based at least partially on Hamner, et al. is dependent upon the patentability of

Claim 1. Thus, the applicants adopt the same arguments made under the analysis of the rejection of Claim 1 with regard to the rejection of the claims under this section of the Reply Brief. Thus, the applicants assert that Claims 3 - 4, 15 - 20, 24 and 27 are patentable.

Conclusion

The applicants assert that all of the claims of the application are non-obvious over all of the references cited by the Examiner, particularly Zimmermann, et al. in consideration of Kerby, et al. The applicants request that all remaining claims of the application be allowed.

CLAIMS APPENDIX

Claim 1. A catalyst for use in stationary or fluid bed dehydrogenation processes for converting hydrocarbons to olefins and/or diolefins, said catalyst consisting essentially of:

a carrier; chromium, as a promoter, in the form of Cr₂O₃, at a concentration from about 10 wt% to about 30 wt%, based on the total catalyst weight; zirconium, as a promoter, in the form of ZrO₂, at a concentration from about 0.1 wt% to about 15 wt% zirconium, based on the total catalyst weight; and magnesium, as a promoter, in the form of MgO, at a concentration from about 0.1 wt% to about 15 wt% magnesium, based on the total catalyst weight.

Claim 2. The catalyst of Claim 1 wherein the carrier is selected from a group consisting of aluminum oxide, alumina, alumina monohydrate, alumina trihydrate, transition alumina, gamma-alumina, delta-alumina, eta-alumina, alumina-silica, silica, silicates, zeolites, bayerite, gibbsite, nordstrandite and combinations thereof.

Claim 3. The catalyst of Claim 1 wherein the carrier has a surface area of from about 15 m²/g to about 300 m²/g, a pore volume of from about 0.2 cc/g to about 1.5 cc/g, and an average pore diameter of from about 3 nm to about 30 nm.

Claim 4. The catalyst of Claim 1 wherein the carrier has a

particle size of from about 20 μm to about 150 μm .

Claim 5. The catalyst of Claim 1 wherein the carrier comprises an alumina carrier that is spray-dried or pelletized and calcined at a temperature from about 500°C to about 1100°C.

Claim 6. The catalyst of Claim 1 wherein the chromium promoter is derived from a member selected from the group consisting of CrO_3 , inorganic chromium salts, ammonium chromate, ammonium dichromate, chromium nitrate, organic chromium salts, and combinations thereof.

Claim 7. The catalyst of Claim 1 wherein the chromium promoter is present in the form of Cr_2O_3 at a concentration from about 15 wt% to about 28 wt%, based on the total catalyst weight.

Claim 8. The catalyst of Claim 1 wherein the chromium promoter is added in the form of a CrO_3 solution that is impregnated onto the alumina carrier.

Claim 9. (Cancelled)

Claim 10. The catalyst of Claim 1 wherein the zirconium promoter is present in the form of ZrO_2 at a concentration of from about 0.5 wt% to about 1.5 wt%, based on the total catalyst weight.

Claim 11. The catalyst of Claim 1 wherein the zirconium promoter is co-impregnated on the carrier with the chromium promoter.

Claim 12. The catalyst of Claim 1 wherein the magnesium promoter is present in the form of MgO at a concentration from

about 0.1 to about 2 wt%, based on the total catalyst weight.

Claim 13. A catalyst for use in stationary or fluid bed dehydrogenation processes for converting hydrocarbons to olefins and/or diolefins, said catalyst consisting essentially of:

a carrier; chromium, as a promoter, in the form of Cr₂O₃, at a concentration from about 10 wt% to about 30 wt%, based on the total catalyst weight; zirconium, as a promoter, in the form of ZrO₂, at a concentration from about 0.1 wt% to about 15 wt% zirconium, based on the total catalyst weight; magnesium, as a promoter, in the form of MgO, at a concentration from about 0.1 wt% to about 15 wt% magnesium, based on the total catalyst weight and from about 0.3 to about 2 wt%, based on the total catalyst weight, of an alkali metal promoter, selected from the group consisting of sodium, potassium and mixtures thereof, expressed in the form of sodium oxide and potassium oxide.

Claim 14. (Cancelled)

Claim 15. A dehydrogenation catalyst consisting essentially of:

a carrier selected from the group consisting of aluminum oxide, alumina, alumina monohydrate, alumina trihydrate, transition alumina, gamma-alumina, delta-alumina, eta-alumina, bayerite, gibbsite,

nordstrandite, alumina-silica, silica, silicates, zeolites and combinations thereof, having a surface area from about 15 m²/g to about 300 m²/g, a pore volume from about 0.2 cc/g to about 1.5 cc/g, and an average pore diameter from about 3 nm to about 30 nm; chromium, as a promoter, calculated as Cr₂O₃, at a concentration from about 15 wt% to about 30wt%, based on the total catalyst weight, wherein the chromium is derived from a member selected from the group consisting of CrO₃, ammonium chromate, ammonium dichromate, chromium nitrate, organic chromium salts, other inorganic chromium salts, and combinations thereof;

zirconium, as a promoter, calculated as ZrO₂, at a concentration from about 0.1 wt% to about 5 wt% zirconium, based on the total catalyst weight; and magnesium, as a promoter, calculated as MgO, at a concentration from about 0.1 to about 2 wt%, based on the total catalyst weight.

Claim 16. The catalyst of Claim 15 wherein the chromium promoter is present at a concentration from about 17 wt% to about 24 wt%, based on the total catalyst weight.

Claim 17. The catalyst of Claim 15 wherein the chromium is added in the form of a CrO₃ solution that is impregnated onto the

alumina carrier.

Claim 18. The catalyst of Claim 15 wherein the zirconium promoter in the form of ZrO_2 is present at a concentration from about 0.5 wt% to about 1.5 wt%, based on the total catalyst weight.

Claim 19. The catalyst of Claim 15 wherein the magnesium promoter in the form of MgO is present at a concentration from about 0.5 to about 1 wt%, based on the total catalyst weight.

Claim 20. The catalyst of Claim 15 wherein the zirconium is co-impregnated on the carrier with the chromium and the magnesium.

Claim 21. (Cancelled)

Claim 22. (Cancelled)

Claim 23. (Cancelled)

Claim 24. A dehydrogenation catalyst consisting essentially of:

a carrier selected from the group consisting of aluminum oxide, alumina, alumina monohydrate, alumina trihydrate, transition alumina, gamma-alumina, delta-alumina, eta-alumina, bayerite, gibbsite, nordstrandite, alumina-silica, silica, silicates, zeolites and combinations thereof, and having a surface area from about $15\text{ m}^2/\text{g}$ to about $300\text{ m}^2/\text{g}$, a pore volume from about 0.25 cc/g to about 0.35 cc/g , and an average pore diameter from about 3 nm to about 30 nm, wherein said carrier is spray-dried or pelletized and calcined;

chromium, as a promoter, calculated as Cr_2O_3 , at a concentration from about 10 wt% to about 30 wt%, based on the total catalyst weight, wherein said chromium is derived from a member selected from the group consisting of CrO_3 , ammonium chromate, ammonium dichromate, chromium nitrate, organic chromium salts, other inorganic chromium salts, and combinations thereof, wherein said chromium is added to the support in the form of a CrO_3 solution that is impregnated onto the carrier;

an alkali metal selected from the group consisting of sodium, potassium and mixtures thereof, as a promoter, calculated as sodium oxide and potassium oxide, at a concentration from about 0.3 wt% to about 2 wt%, based on the catalyst weight;

zirconium, as a promoter, calculated as ZrO_2 , at a concentration from about 0.1 wt% to about 15 wt% zirconium, based on the total catalyst weight; and

magnesium, as a promoter, calculated as MgO , at a concentration from about 0.1 wt% to about 15 wt% magnesium, wherein the magnesium is co-impregnated on the carrier with the chromium and zirconium.

Claim 25. (Cancelled)

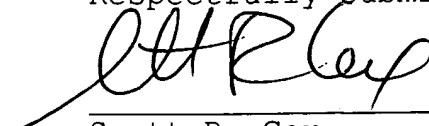
Claim 26. (Cancelled)

Claim 27. The catalyst of Claim 24 wherein the alkali metal

promoter comprises about 0.3 to about 1 wt% Na₂O, based on the total catalyst weight.

Claim 28. The catalyst of Claim 13 wherein the alkali metal promoter comprises about 0.3 to about 1 wt% Na₂O, based on the total catalyst weight.

Respectfully submitted,



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